Marco Forgione

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Born in Varese (Italy) on 6/7/1986

Areas of Expertise

Systems & Control Modeling, simulation, and control of complex dynamical systems. Estimation, system identification, signal processing, optimization.

Machine learning Supervised and unsupervised machine learning techniques. Bayesian Optimization, Gaussian Processes, Deep Learning.

Computer Engineering Advanced use of numerical and statistical software packages. Good programming and server administration skills.

Current position

2018-now **Researcher**, *Dalle Molle Institute for Artificial Intelligence (IDSIA)*, Manno, Switzerland.
My research interests lie at the intersection between Automatic Control and Machine Learning.

Previous Position

2018 **Software Engineer**, *SMS Spinnler Fleury AG*, Balerna, Switzerland.
I worked as Software Engineer in SMS Spinnler Fleury AG. The company develops and builds industrial micro-assembly machines. My main tasks were:
- Python scripting for automatic code generation and versioning.
- PLC software development in IEC 61131-3 language.
- After-sales customer support (troubleshooting of PLC and HMI software issues).

2015-2017 **Control Engineering Consultant**, *Whirlpool EMEA*, Biandronno (VA), Italy.
I took part in several R&D projects within the Advanced Development group of Whirlpool. In particular, I was engaged in the following activities:
- Development of temperature estimation and control algorithms for induction cooktops.
- Development of doneness estimation algorithms using humidity measurements.
- Modeling and control of half-bridge and quasi-resonant power converters.
- Implementation of an hardware-in-the-loop software platform for real-time algorithm testing.
- Development of control algorithms for electrically-operated gas valve.

I made extensive use of the Matlab, Python, and C programming languages for algorithm development, data visualization and signal processing. Furthermore, I employed statistical methodologies (Six-sigma) and software (Minitab) in order to plan and analyze the validation experiments required to demonstrate the robustness of my algorithms with respect to different nuisance factors.

2014 – 2015 **Postdoctoral researcher**, *Ecole Centrale de Lyon*, France.
I pursued my research in cooperation with the CEA institute of Grenoble aiming to develop novel architectures for phase-locked loop circuits with applications to wireless telecommunications. Furthermore, I was teaching assistant for the courses “Signal processing” and “Analog to digital converters”.

Education

2010 – 2014 **PhD in Systems and Control**, *Delft University of Technology*, The Netherlands.
Thesis title: *Batch-to-batch learning for model-based control of process systems with application to cooling crystallization.*

2007 – 2009 **MSc in Computer Engineering**, *Università degli Studi di Pavia.*
Final grade: **110/110 cum laude**.
Average grade: **29.6/30**.
Thesis title: *Artificial Pancreas: black-box identification of the glucose-insulin metabolisms.*

2004 – 2007 **BSc in Computer Engineering**, *Università degli Studi di Pavia.*
Final grade: **110/110 cum laude**.
Average grade: **29.4/30**.
Thesis title: *Design, realization and control of a laboratory-scale gantry crane.*

Postdoctoral Research Topic

title *Low phase-noise radio-frequency synthesis.*

description I carried out my research project within the Low Phase noise radio-frequency SYnthesis (LOPSY) project at the Ampère Laboratory of Lyon and in collaboration with the CEA institute of Grenoble. In wireless telecommunications, Phase-Locked-Loops (PLL) are widely utilized for the generation of oscillating signals required for the modulation/demodulation operations. In a nutshell, a PLL is a feedback system where a signal generated by a Voltage-Controller Oscillator (VCO) is synchronized with a reference oscillator. A feedback controller generates a voltage command for the VCO which enables synchronization, while honoring constraints on the output phase noise. An intrinsic limitation of the classical PLL structure is that a single degree of freedom - the feedback controller - is available for the rejection of multiple noise sources. Thus, the latter cannot be handled independently from each other. The goal of this project was to overcome this limitation by developing a novel 2 Degrees of Freedom PLL architecture where the reference phase noise is on-line measured and compensated for by a feedforward controller. I was mainly involved in the system behavioral modeling using the Simulink/Simscape environment and the design of control algorithms using an H_∞ approach.

PhD Research Topic

title *Batch-to-batch learning for model-based control with application to batch cooling crystallization.*

supervisors Dr. Paul M.J. Van den Hof and Dr. Xavier Bombois.

description I carried out my PhD within the "Intelligent Observer and Control for Pharmaceutical Batch Crystallization" project supported by the Institute for Sustainable Process Technology (ISPT). Two Dutch universities (TU Delft and TU Eindhoven) and several companies (DSM, Albemarle, FrieslandCampina, MSD, Zeton, IPCOS, DotX, etc.) participated in this project. The goal of my research was to develop and validate algorithms for improving from run to run the performance of model-based controllers for industrial batch processes. My approach consisted in using the measurement collected during one batch run to refine the model used by the controller in the next batch run adopting a Bayesian estimation framework. I demonstrated the potential of this method through extensive numerical simulations and real experiments performed both on pilot-scale and industrial-scale batch crystallizers.

Professional Skills

Systems modeling: First-principles and data-driven modeling of different engineering systems. System identification, parameter estimation, time series analysis.

Control design: Design of classical, PID, H_∞, MPC, and ILC control algorithms.

Signal Processing: Time/frequency domain signal analysis, analog and digital filter design.

Scientific software: MATLAB, Simulink, Minitab, Modelica.

Programming languages: Python, C, Labview, IEC 61131-3.

Server administration: Apache, LDAP, MySQL, SVN.

Instrumentation: Oscilloscope, function generators, spectrum analyzer, etc.

Academic Skills

Scientific output: I am co-author of 5 journal papers and 11 conference proceedings. I presented my scientific results in several international conferences in the Systems and Control Field. I delivered a plenary lecture at the 2013 European Network on System Identification.

Teaching assistant: Signal processing and Analog to Digital Conversion at the Ecole Centrale de Lyon (in French). Process Control, System Identification, and Control Systems Design at the Delft University of Technology (in English).

M.Sc. thesis supervision: I supervised two M.Sc. student theses at the Delft University of Technology.

Languages

Italian	Mother tongue	
English	Fluent	*4-year teaching and working experience*
French	Fluent	*1-year teaching and working experience*
Dutch	Basic	*B1 certificate obtained in 2012*

Publications

M. Forgione., X. Bombois, and P.M.J. Van den Hof. Data-driven model improvement for model-based control. *Automatica*, 52:118–124, February 2015.

M. Forgione, G. Birpoutsoukis, X. Bombois, A. Mesbah, and P.M.J. Van den Hof. Batch-to-batch model improvement for cooling crystallization. *Control Engineering Practice*, 41:72–82, 2015.

A. Mesbah, X Bombois, J.H.A. Ludlage, H. Hjalmarsson, **M. Forgione**, and P.M.J. Van den Hof. Performance diagnosis and plant re-identification. *International Journal of Control*, 88(11):2264–2276, 2015.

S. Kadam, J. Vissers, **M. Forgione**, R. Geertman, P.J. Daudey, A. Stankiewicz, and H.J.M. Kramer. Rapid crystallization process development strategy from lab to industrial scale with PAT tools in skid configuration. *Org. Process Res & Dev.*, 16:769–780, 2012.

L. Magni, **M. Forgione**, C. Toffanin, C. Dalla Man, G. De Nicolao, B. Kovatchev, and C. Cobelli. Run-to-run tuning of model predictive control for type 1 diabetes subjects: *in silico* trial. *Journal of Diabetes Science and Technology*, 3:1091–1098, September 2009.

M.G. Potters, **M. Forgione**, X. Bombois, and P.M.J. Van den Hof. Least-costly experiment design for uni-parametric linear models: An analytic approach. In *Control Conference (ECC), 2015 European*, pages 848–853. IEEE, 2015.

M. Forgione, X. Bombois, P.M.J. Van den Hof, and H. Hjalmarsson. Experiment design for parameter estimation in nonlinear systems based on multilevel excitation. In *Proceedings of the 2014 European Control Conference*, pages 25–30, Strasbourg Convention and exhibition center, Strasbourg, France, June 2014.

M.G. Potters, X. Bombois, **M. Forgione**, P.E. Modén, M. Lundh, H. Hjalmarsson, and P.M.J. Van den Hof. Experiment design in closed loop with unknown, nonlinear or implicit controllers using stealth identification. In *Proceedings of the 2014 European Control Conference*, pages 726–731, June 2014.

A.C.P.M. Backx, X.J.A. Bombois, P.J. Daudey, **M. Forgione**, R.M. Geertman, P.M.J. Van den Hof, S.S. Kadam, H.J.A. Kramer, J.A.W. Vissers, P. Vonk, and G.M. Westhoff. Towards a more rigorous control of seeded batch crystallization. *Abstract presented at the 19th International Symposium on Industrial Crystallization*, Tolouse, France, September 2014.

M. Forgione, X. Bombois, and P.M.J. Van den Hof. Experiment design for batch-to-batch model-based learning control. In *Proceedings of the 2013 American Control Conference (ACC)*, pages 3918–3923, Reinassance Hotel, Washington, D.C., USA, June 2013.

A. Mesbah, X. Bombois, **Forgione, M.**, J. Ludlage, P. Modén, H. Hjalmarsson, and P.M.J Van den Hof. A unified experiment design framework for detection and identification in closed-loop performance diagnosis. In *Decision and Control (CDC), 2012 IEEE 51st Annual Conference on*, pages 2152–2157. IEEE, 2012.

M. Forgione, A. Mesbah, X. Bombois, and P.M.J. Van den Hof. Batch-to-batch strategies for cooling crystallization. In *Proceedings of the 51st IEEE Conference on Decision and Control*, pages 6364–6369, Grand Wailea, Maui, Hawaii, December 2102.

M. Forgione, A. Mesbah, X. Bombois, and P.M.J. Van den Hof. Iterative learning control of supersaturation in batch cooling crystallization. In *Proceedings of the 2012 American Control Conference*, pages 6455–6460, Fairmont Queen Elizabeth, Montreal, Canada, June 2012.

S. Kadam, J. Vissers, **M. Forgione**, P.J. Geertman, R. Daudey, and H.J.M. Kramer. Rapid determination of a near-optimal seeding procedure at an industrial scale batch crystallizer. In *Proceedings of the 18th International Symposium on Industrial Crystallization*, pages 141–142, ETH Zurich, Zurich, Switzerland, September 2011.

J. Vissers, **M. Forgione**, S. Kadam, P.J. Daudey, T. Backx, A.E.M. Huesman, H.J.M. Kramer, and P.M.J. Van Den Hof. Novel control of supersaturation on an industrial scale pharmaceutical batch crystallizer. In *Proceedings of the 18th International Symposium on Industrial Crystallization*, pages 141–142, ETH Zurich, Zurich, Switzerland, September 2011.